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SPHAGNUM IN SOUTH AFRICA.

By S. Garside.

(With Plates IX—X)

Introduction.

Although the genus Sphagnum is recognised at sight by all botanists, the determination of species is a more difficult matter. In South Africa, those who require specific names will naturally turn to Dr. T. R. Sim's work on the Bryophyta of South Africa,(8) but unfortunately, owing to errors and omissions in both the key and descriptions of Sphagnum, it is very unlikely that a correct determination will be made.

A study of his herbarium has shown that Dr. Sim treats only of those specimens which he had in his collection, and this has resulted in the relegation to a footnote of *S. Balfourianum* and *S. Marlothii*, and the splitting-up of *S. truncatum* sens. lat. into two species, *S. truncatum* Horns. and *S. Rehmannii* Warnst. emend. Sim., which are only growth-forms taken from a long interconnected series.

Dr. Sim also devotes much space to the names of Rehmann's exsiccata of South African Sphagnum, listed in (2), but this is of little or no value to the student who may not be able to see them.

The key to Sphagnum given by Dr. Sim is based on a division of the species into two groups of leaf forms, but that Dr. Sim himself found this difficult in practice is shown by his determination of *S. laceratum* (at that time not recorded for South Africa) as *S. capense* Horns.

His object was to simplify the subject for "those many botanists who wish in the first case to know the mosses of South Africa before they begin to search for slight varietal or form modifications, and wider grouping has consequently been here adopted" (8, p. 129), but as the fundamental distinctions between species are cell details, only to be seen with the microscope, his references to leaf shape in the key are not very helpful.

Too much stress is also laid on the presence or absence of pores in the hyaline cells, a feature now known to be for the most part epharmonic rather than specific.

Dr. Sim very properly reduced many of the described species to synonymy, making of sixteen species originally cited in his preliminary list(7) only six in the final work.(8)

Since Dr. Sim wrote, two species new for South Africa have been discovered, *S. fimbriatum* Wils. (3, p. 248 and 9, p. 19) and *S. laceratum* Warnst., recorded here for the first time. Much careful collecting has still to be done before a complete revision of the genus for South Africa can be attempted, and this paper must be regarded only as presenting some aspects of modern work on variation which should be of help to the student in the field, and as providing a revised key and notes for species determination.

Resorption Phenomena.

In most species of Sphagnum, a certain amount of resorption of cell-wall substance takes place in special groups of cells, leaving either thin places or actual gaps or perforations in the cell-walls.

In *S. Balfourianum*, for example, the outer cortical cells of the main-stem and lateral-branches each have a single circular aperture formed in this way (Fig. 1C). Resorption is also frequent in the stem-leaves of certain species, the entire outer and inner walls of the hyaline cells disappearing completely so that the leaf consists of an open network composed almost entirely of partition walls, *e.g. S. laceratum* (Fig. 5Sm) and *S. Pappeanum* (Fig. 4Sm).

Many species of Sphagnum lose the outer walls of all the cells which border the extreme margin of the branch-leaf, resulting in the formation of what is termed the "resorption-furrow" (Figs. 1Bt and 4Bt). The resorption-furrow is of great importance for taxonomic purposes as it is characteristic of two large sub-sections of the Warnstorf classification, sub-section Rigida (with *S. Pappeanum*) and sub-section Cymbifolia (with *S. Balfourianum*).

The furrow is readily observed by cutting very thin sections of a leafy lateral-branch, for which dry material may be used, the sections being afterwards expanded by mounting in water or in glycerine-jelly containing some stain. Care must be taken that the true edge of the leaf is examined and not the broken end of a section.

If the branch, when seen in surface view, appears to be bordered by a thin, delicate membrane (Figs. 1Bc and 4Bc), this indicates the presence of the resorption-furrow, and contrasts markedly with the margin of thickened and extremely elongated cells forming the distinct border which is usually present in leaves without the furrow (Figs. 5Bc and 6Bc). It is a curious fact that no mention is made of the resorption-furrow in most of the botanical text-books.

JUVENILE STATES.

The species identification of the juvenile states of Sphagnum presents considerable difficulties and the student of the genus will be well advised not to attempt it at first, until he has made himself familiar with mature plants showing clear differentiation into main-stem and lateral-branches. Indeed, Le Roy Andrews (4, p. 8) has remarked: "In the case of 'juvenile' or otherwise incomplete or abnormally developed specimens, the stem-leaves have sometimes led bryologists, including Warnstorf, to a misunderstanding of even the species involved."

Juvenile plants consist of a simple axis bearing leaves which are often very similar to those borne on the lateral-branches of mature plants, though they are usually larger. Aberg (1, p. 6) terms such states "subsimplex" (Pl. IX, Fig. 1). If the young plant has developed simple lateral-branches, it is "monocladous," and if further developed, with fascicles of two or three branches, it is "oligocladous" (Pl. IX, Figs. 2 and 3).

It is impossible at present to make a key to the juvenile states of the South African species, as only those of *S. truncatum* sens. lat. are known with certainty, though *S. panduraefolium* is suspected of being the juvenile state of *S. capense* Horns. The others await discovery. When found, juvenile states should be carefully collected, and the species of Sphagnum growing in the vicinity should be determined. It is important to note that growth may be arrested at one of the juvenile states, and the plants may continue to vegetate until large masses are formed. Warnstorf(10) has described some of these as species. In South Africa, *S. panduraefolium* may be such a case of arrested development, and the juvenile state of *S. truncatum* may persist and vegetate for a long period in aquatic habitats.

The phases of transition from the juvenile state to the mature state may also remain in an arrested condition. It is suggested (v. inf.) that *S. capense* Horns. may be one of these. Such arrested states usually have stem-leaves with a structure intermediate between the completely isophyllous leaves of juvenile states and the anisophyllous condition of mature plants, where the stem- and branch-leaves are usually very different, one of the main differences being that the stem-leaves show a reduction or total loss of fibres and a much greater degree of resorption, the hyaline cells often having large membrane gaps in their outer walls, or these walls may completely disappear.

VARIATION IN SPHAGNUM.

In 1911, a monographic account of the species of Sphagnum for the world was published by Warnstorf(10) containing descriptions of 342 species. Of recent years, some aspects of Warnstorf's work have been considerably modified, particularly as regards his species concept.

Indeed, Le Roy Andrews (4, p. 12), who examined Warnstorf's herbarium at Dahlem, Berlin, doubted that "any really critical student, even with a fairly liberal concept of species could make out more than a hundred species of Sphagnum." It seems that Warnstorf took little account of epharmonic forms, and described all these as species, and although his descriptions are excellent, later workers are of the opinion that many of his species must be reduced to synonymy.

It is necessary to have a long series of specimens before epharmonic variation can become obvious, and this Warnstorf certainly had not got for the South African species. An examination by the present writer of Sim's herbarium also shows that his series of forms was insufficient, and resulted in his separation of a sub-aquatic form of *S. truncatum* sens. lat. from the forms of drier habitats, which he called *S. Rehmannii* Warnst. emend. Sim.

The Sub-section Subsecundum of the genus Sphagnum, to which *S. truncatum* and *S. capense* belong, is one in which the species are now known to exhibit a very great range of variation in growth-form.

Aberg(1) has made a critical study of this group for the European species and has devised a somewhat complex series of descriptive terms for the growth-forms, which can, however, be directly and usefully applied to the South African species. The variations concerned in a single species may cover the relative crowding or sparseness of the lateral branches on the main axis, and their size, length and thickness, the degree of compactness or divergence of the leaves on the lateral-branches, and the direction and curvature of the branches themselves. Aberg's paper(1) should be consulted for the terminology of growth-form. Plate IX illustrates a full series of variations in growth-form for *S. truncatum* sens. lat.

Aberg has also devised a series of terms expressing the variability in frequency and distribution of the pores in the hyaline cells of the leaves.

In general, aquatic forms have larger leaves and pore formation is very much reduced. Many of Warnstorf's species (including some from South Africa) and some sections of his keys, are based upon differences in number of pores, and are consequently for the most part worthless. There is still much work to be done on epharmonic variation in the South African species, as the full range of growth-form for most of the species is still unknown, and hence the need for comprehensive collections, accompanied by careful notes on the conditions of the habitat, including light intensity and Ph value of the water supply. Fortunately, dried plants of Sphagnum keep their characters and can at any time be studied for variations in pore distribution. Little reference has been made to this subject in this paper, as it does not directly concern taxonomy, and those undertaking such a study should consult Aberg's work.(1)

For a simple demonstration of the effects of altered environment, it is usually possible to grow fresh Sphagnum, taken from a relatively dry habitat, in an aquarium or tank kept in a cool place for a month or six weeks.

FRUITING OF SPHAGNUM IN SOUTH AFRICA.

When Dr. Sim wrote his account of Sphagnum (8, p. 129) he reported that although archegonia and antheridia occur, capsules are not recorded, with the exception of a single capsule found by Warnstorf on one of the Rehmann exsiccata in the Berlin Herbarium.

Since this time, however, more fruiting stages have been collected, and whilst Sphagnum does not appear to fruit as readily in South Africa as it does in the northern hemisphere, fruits are probably more common than has been supposed; it is merely that so few collections of Sphagnum have been made. More recent records of fruiting are *S. fimbriatum* Wils. found at George.(3) said to be the first record of the species for South Africa, and claimed as "the first time that any species of Sphagnum has been found fruiting in South Africa." This material of *S. fimbriatum* is not in Dr. Sim's herbarium.

S. capense Horns. is recorded in a later paper(9) as fruiting in Diamond Stream, Kirstenbosch, Cape Peninsula, 29 November, 1929, with abundant capsules which were overtopped by leaves. Sim considered that this might be a specific character, but the specimen, which is in Dr. Sim's herbarium, No. 10301, proved to be *S. pycnocladulum*, so that this is the first record of this species in fruit. Plants of the same species were found fruiting at the top of Disa Gorge, Table Mountain, by Miss Walgate, February, 1947, and in these, the sporogonia were elevated above the perichaetial leaves on long pseudopodia, so that Dr. Sim's specimens No. 10301 were probably not fully developed.

SPHAGNUM AND SOUTH AFRICAN PALYNOLOGY.

A striking feature of recent work on pollen-analysis is the part played by Sphagnum peat in retaining pollen-grains carried by the wind from the surrounding vegetation to the Sphagnum swamps of former times.

In South Africa, there are no extensive Sphagnum swamps such as are found frequently in northern Europe and America, and only rarely do we find small marshes and pools on the mountain summits, where Sphagnum can grow. Stream-sides, rock fissures, and the so-called "flushes" on mountain slopes, where water issues from the ground, are the usual habitats, and as Dr. Sim remarks (8, p. 129) "the total quantity of Sphagnum in South Africa is extremely small."

The present writer has examined many South African collections of recent Sphagnum (not peat) and has noted a general absence of pollen grains of native species of plants. A few grains, apparently of Restionaceae, are all that have occurred, and it appears that air-borne pollen is decidedly uncommon in these Sphagnum tufts. On the other hand, pollen-grains of Pinus, frequently planted on Table Mountain, have been noticed from time to time in material from this locality.

THE TYPE SPECIMENS OF SOUTH AFRICAN SPHAGNUM.

The moss herbaria of Hornschuch, Laurer, V. F. Brotherus and C. Müller, as well as Warnstorf's Sphagnum herbarium were at Dahlem, Berlin. Warnstorf's herbarium, on which his "Sphagnologia Universalis" was based, contained 30,000 specimens, as well as numerous types. All these have been destroyed during the recent war, and it is much to be deplored that so few duplicates and co-types have found a resting place in South Africa, where they would be of the greatest value. Although the actual authors' types have been lost, there are in other herbaria many duplicates of the Drège plants and the exsiccata of Rehmann, on which several species are based.

Anyone who undertakes a critical revision of the South African Sphagnaceae will have to make use of these in lieu of type-specimens. The first two species of Sphagnum to be described from South Africa were *S. truncatum* Horns. and *S. capense* Horns., both from the collections of Drège.

THE PREPARATION AND EXAMINATION OF MATERIAL.

A remarkable feature of Sphagnum is the manner in which minute details of cell-wall structure are retained in dry or herbarium material, so that they can be accurately examined even after only a brief soaking in water. As the main sections of the key which follows are concerned with the characters of the cortical cells and of the cauline or stem-leaves. it is necessary to examine these very carefully. The Subgenus Inophloea, termed a subgenus in the new classification of Le Roy Andrews,(4) but called a section in Warnstorf's classification,(10) is characterised by the presence of fibres in the cortical cells of stem and branches, but occasionally these fibres may be very reduced or even absent in the stem-cortex, so that it is better to examine the branch-cortex for this character, where it can be readily observed after dissecting away a few branch-leaves. Spreading or erect branches are the best to use, taken from a vigorous plant showing good differentiation into main-axis and lateral fascicles of branches: if branching is not of this nature, a juvenile state is indicated.

For rapid work, stem-leaves can be detached from the dry material with fine forceps, and after dipping in spirit, to remove air, they are mounted in water for examination. This method is only recommended for use when the student has become familiar with the species and requires merely a few confirmatory details. A more thorough examination should be made by staining an entire plant, previously soaked in water, in a water-solution of genetian-violet. This requires a few seconds only. but the material does not overstain if left for a much longer period. Washing in tap-water follows, to remove all superfluous stain, and the material can then be placed in clean water in a dish, under the dissecting microscope, and the required parts removed with fine forceps, and examined in water or dilute glycerine. Permanent preparations are useful for reference, and can be made by mounting the stained parts in alkaline glycerine-jelly, made with:—

Davis (food) gelatine	5 gms.
Water	30 cc.
Glycerine	35 cc.
Undiluted T.C.P. (antiseptic) ..	5 cc.

The gelatine is dissolved in the water by heating, the glycerine added and finally the T.C.P. This gives a highly alkaline jelly which does not decolourize the genetian-violet, as will a jelly made in the usual way by the addition of phenol. The writer has found that the liquid sold as fishing-rod varnish can be used as an effective seal for ringing the slides.

Material can also be stained in bulk in gentian- or methyl-violet, and then re-dried and placed in the herbarium. In this condition it will be readily available at any time, and only requires soaking in water for immediate examination. The use of stained material is strongly recommended, as it greatly facilitates the observation of cell detail.

Key to the South African Species of Sphagnum.

1. Hyaline cells of the branch-cortex with fibres:—
Subgenus I. Inophloea Russ. 2
Hyaline cells of the branch-cortex without fibres:—
Subgenus II. Lithophloea Russ. 3

2. Hyaline cells of the branch-leaves with pores near the commissures only .. .. *Balfourianum*
Hyaline cells of the branch-leaves with commissural pores and also with 1—3, rarely 4—5 small superficial perforations .. .. .. *Marlothii*

3. Hyaline cells of the stem-leaves without fibres 4
Hyaline cells of the stem-leaves with fibres, either in the upper portion of the leaf only, or throughout 7

4. Stem-leaves spathulate (narrower at the base than above) the rounded apex finely fringed at the margin. Branch-cortex with retort-cells *fimbriatum*
Stem-leaves lingulate (tongue-shaped) or triangular or oval, apex rounded, entire or mucronate or dentate 5

5. Stem-leaves without pores in the hyaline cells 6
Stem-leaves with pores in the hyaline cells, especially in the upper half .. .. *pycnocladulum*

6. Stem-leaves shortly triangular, hyaline cells mostly not obliquely septate, extreme edge of branch-leaf bordered by a delicate membrane *Pappeanum*
Stem-leaves broadly lingulate, hyaline cells all obliquely septate, branch-leaves with a border of elongated, thick-walled cells .. .. *laceratum*

7. Branch-leaves almost uniform in size on a single branch, oval, deeply concave, apex pointed or minutely 2—5-dentate. Branch-cortex with retort-cells 8
Branch-leaves usually varying in size on a single branch, ovate-lanceolate to lanceolate, apex truncate, 2—12-dentate, rarely entire. Retort-cells none .. .. *truncatum*

8. Main stem and lateral branches not clearly differentiated. Stem- and branch-leaves similar, apex cucullate and entire or finely toothed, hyaline cells fibrous throughout the leaf and usually with pores *panduraefolium*
Main stem and lateral branches well differentiated, stem-leaves lingulate or oval, the hyaline cells with fibres and pores throughout the leaf, or fibrous in the upper part only, the lower hyaline-cells having only pores or membrane-gaps, or imperforate. Branch-leaves 2—5-dentate at apex .. .. *capense*

Explanation of the Lettering of Text Figures. 1—8.

S.	Stem-leaf.
Su.	Stem-leaf cells from upper part of leaf.
Sm.	Stem-leaf cells from middle part of leaf.
Sl.	Stem-leaf cells from lower part of leaf.
B.	Branch-leaf.
Bc.	Cells of branch-leaf.
Ba.	Apex of branch-leaf.
Bt.	Section of branch-leaf.
C.	Cortex of branch-leaf, surface view.
T.	Cortex of stem, transverse section.

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NOTES ON THE SPECIES.

1. **S. Balfourianum** Warnst. in Hedwigia 30 (1891) 153.

Fig. 1 and Pl. X, No. 7.

A large, robust plant; pale-green when fresh, pale buff-coloured when dry; branch-leaves with cucullate apex, the margins inrolled and with a resorption-furrow (Fig. 1Bc and Bt). Stem-cortex 2—3, rarely 4 cells thick, with large perforations in the cell-walls of all the cells (Fig. 1T), its superficial cells with faint fibres and each cell with an external pore. Woody cylinder brown. Stem-leaves diverse in size (Fig. 1S, both upper and lower) the smaller triangular or spathulate and efibrose, the larger lingulate, fibrose in the upper half only, or throughout.

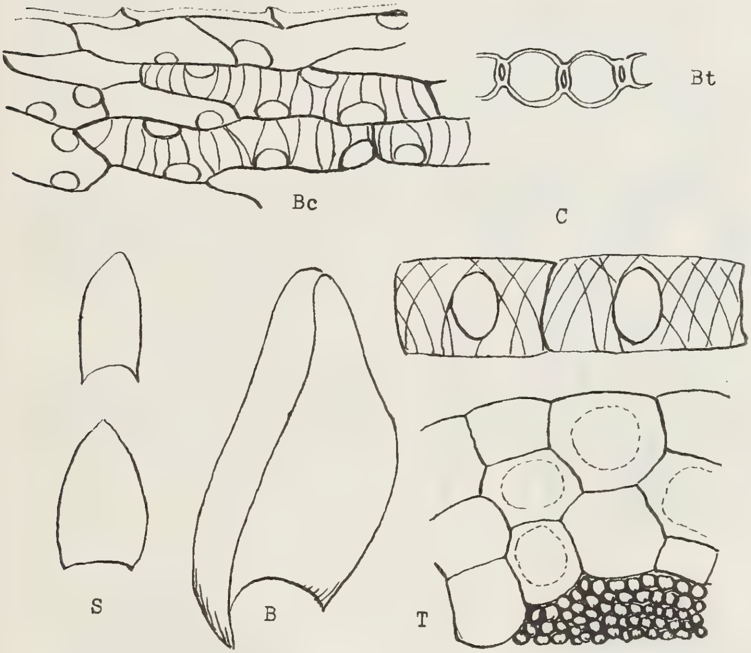

FIG. 1. *S. Balfourianum* Warnst. Drawn from *Pillans* 4280, south-west side of Groot Kop, Cape Peninsula.

Type from Mauritius, leg. Balfour; also in Madagascar. In South Africa known only from the Cape Peninsula: *Pillans* 4280; *Esterhuysen* 15839, but probably has a much wider distribution.

2. S. Marlothii Warnst. in Sphag. Univ. (1911) 471.

Probably not a good species, but merely a modification or growth-form of *S. Balfourianum*, with which it agrees in most features, but is distinguished by the minute pores in the hyaline cells in the upper portions of the branch-leaves.

Known only from the type collecting, Table Mountain, Cape Peninsula, 3346 ft., *Marloth*, in Herb. Dahlem.

3. S. fimbriatum Wils. in Hook. Fl. Antar. II (1847) 398.
Fig. 2.

Plants never red. Stem cortex 2—3-layered, superficial cells each with 1—3 large round pores. Wood pale greenish to yellowish, never red. Stem-leaves broadly spathulate, the upper half wider, its margins fringed by the disintegration of the hyaline cells. Branch-leaves ovate-lanceolate, up to 2 mm. long and 1.2 mm. wide, with a border of thickened cells: apex 5-dentate.

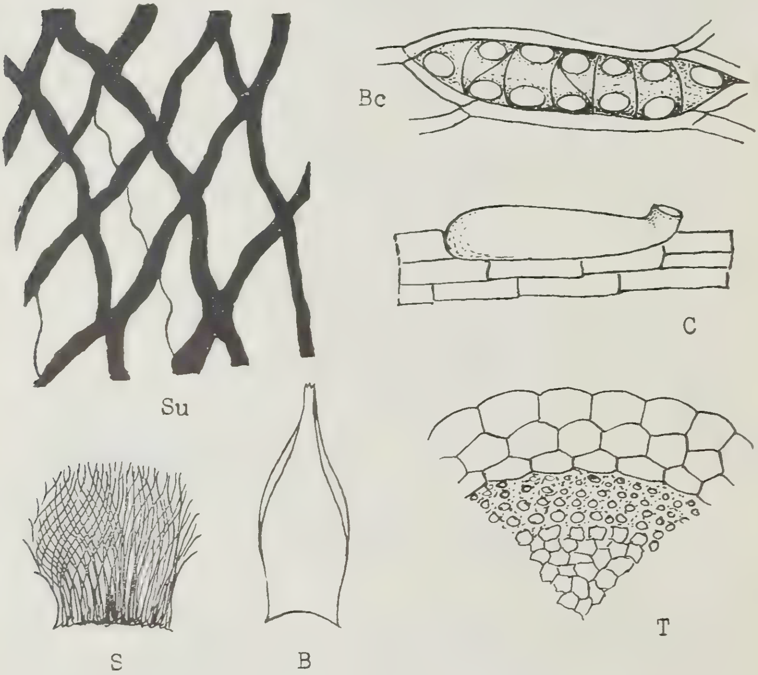

FIG. 2. *S. fimbriatum* Wils. Fig. S after Warnstorf, Sphag. Univ., Fig. 21A; the remainder from Braithwaite's "Sphagnaceae" (1878) Plate 16.

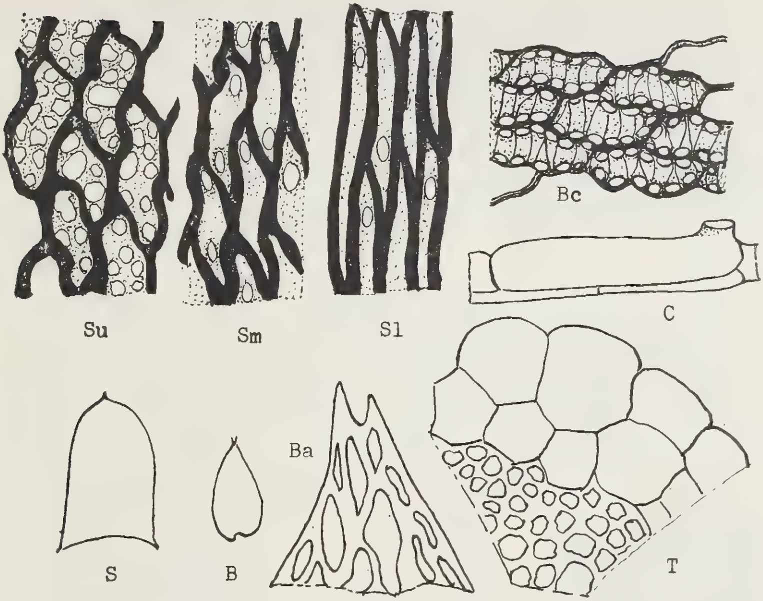

Fig. 3. *S. pycnocladulum* C.M. From *Rehmann* Ex., No. 17.

Widely distributed in the northern hemisphere in sub-arctic, temperate and Mediterranean regions, and in the southern hemisphere known from Chile, Patagonia and New Zealand. At present known from South Africa only from a single collecting at George, recorded by Dixon and Wager.(3) This material is not in Dr. Sim's Herbarium, and has not been seen by the present writer.

4. S. pycnocladulum C.M. in Flora (1887) 420.
Fig. 3 and Pl. X, Nos. 1, 2 and 3.

Stem-cortex of 2 layers of cells, the superficial cells each with a single pore or a thinner spot. Stem-leaves lingulate, apex rounded, mucronate (Fig. 3S), its hyaline cells efibrous throughout the leaf, the upper cells having numerous small, often irregular pores (Fig. 3Su) the more elongated middle and lower cells with one or two oval membrane-gaps (Fig. 3, Sm and Sl). Branch-leaves small, deeply concave, apex bifid (Fig. B and Ba), rarely entire, the hyaline cells with numerous fibres, and pores usually arranged in moniliform series along the commissures (Fig. 3Bc), sometimes with superficial pores. Retort-cells moderately developed (Fig. 3C).

Warnstorf distinguished two "varieties" of this species:—

var. *viride* Warnst. in Sphag. Univ. (1911) 176.

"Plants green above, robust, up to 20 cm. long."

var. *fuscescens* Warnst. loc. cit.

"Plants 10 cm. long, with dense dull subfuscous heads."

These are obviously nothing more than growth-forms, and can be neglected. Three frequent growth-forms are shown on Pl. X, Nos. 1, 2 and 3, No. 1 being dark-green, No. 2 fuscescent and No. 3 pale yellowish-white.

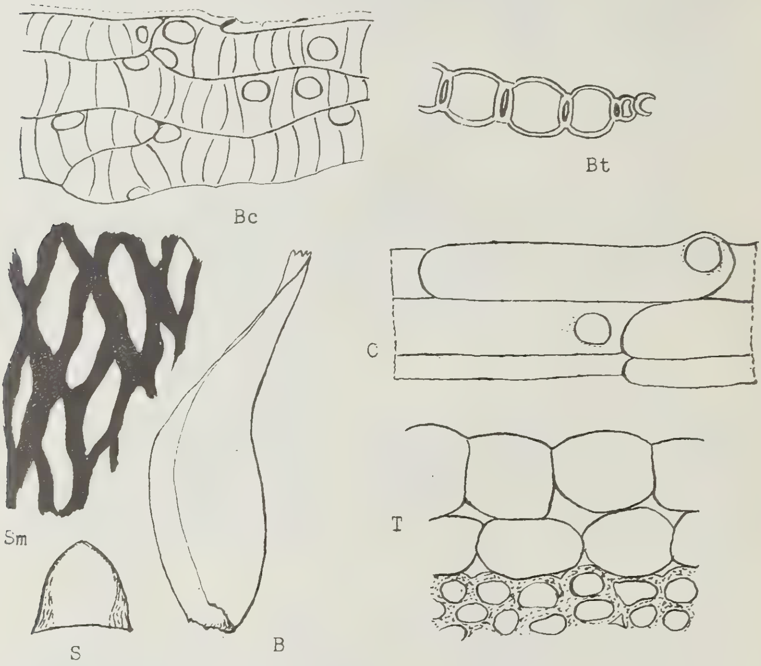

Fig. 4. *S. Pappeanum* C.M. From *Esterhuysen* 15049.

This species is known only from South Africa, where it appears to be widely distributed in the mountainous districts of the west.

Cape Peninsula, Window Gorge, Table Mountain, *Esterhuysen* 15362; Hex River Mts., Sanddrift Kloof, *Esterhuysen* 15427; River Sonderende Mts., *A. Wilman* 535.

See also remarks under *S. capense*.

5. S. Pappeanum C.M. in Syn. I (1849) 101.
Fig. 4 and Pl. X, No. 8.

This, when well-grown, is the most robust of all the South African species, but it occurs also in a stunted condition. Pale-green when fresh, white or grey when dry, with large branches bearing squarrose leaves. Branch-leaves with a resorption-furrow and a membranous edge (Fig. 4Bc and Bt).

Type from Swellendam, leg. *Pappe* in 1838. Known from the Isles of Amsterdam, Bourbon and Teneriffe; also in Central Africa, Ruwenzori.

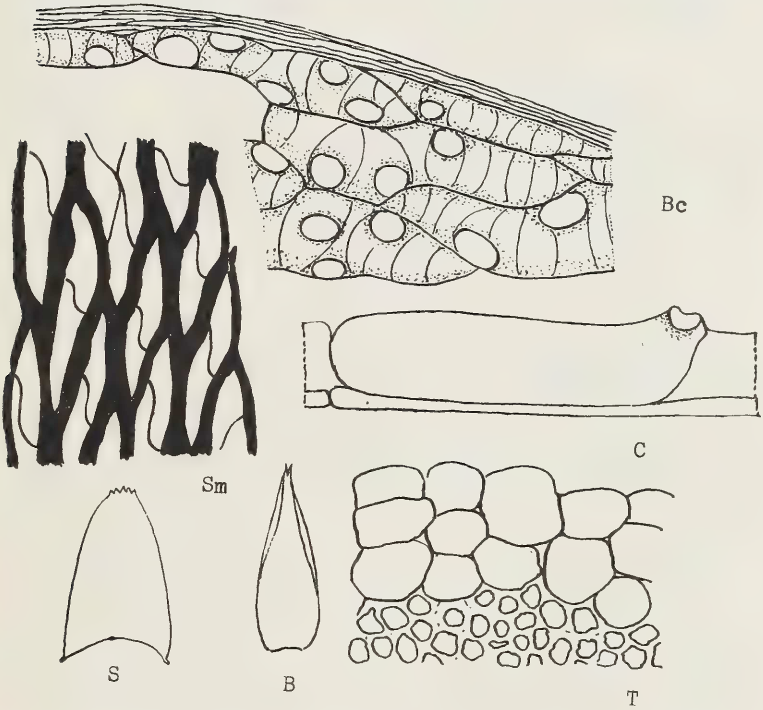

Fig. 5. *S. laceratum* Warnst. From *Stokoe* 9261, in Herb. Bolus., from River Sonderende Mts.

In South Africa it has been little collected so far, Hex River Mts., *Esterhuysen* 15049; Natal (in fruit), *Schelpe* 1704.

6. S. laceratum C.M. et Warnst. apud Warnst. in Hedwigia 36 (1897) 149.

Fig. 5 and Pl. X, No. 6.

This species is characterised by its pink or red colour, which extends even to the woody cylinder of the stem. Branch-leaves lanceolate, closely imbricate, and with few but very large pores, often placed in opposite pairs on the inner and outer walls of the hyaline cells. When stained with methyl-violet, the leaf appears to be pierced with numerous large holes. A very distinct species, previously known only from Brazil. Type, Minas Garaes, leg. *E. Ule* 1294. Recorded for South African from only two localities; River Sonderende Mts., *A. Wilman* 527; Riversdale, Garcias Pass *G. Thorne* (Nov. 1926, the first record), S.Af. Mus. Herb. 38817; and *Muir* (July, 1930), Dept. Agric. Herb. Crypt. 4138.

7. **S. truncatum** Horns. emend. Garside, including:—
S. truncatum Horns. in Linnaea XV (1841) 114.
S. Bordasii Besch. in Ann. Sci. Nat. Ser. 6, Vol. 10 (1880) 330.
S. coronatum C.M. in Flora (1887) 412.
    et var. *cuspidatum* Warnst. Sphag. Univ. (1911) 306.
S. oligodon C.M. in Flora (1887) 412,
    et var. *Bachmannii* Warnst. Sphag. Univ. (1911) 363,
    et var. *Beyrichii* Warnst. Sphag. Univ. (1911) 364.
S. marginatum Warnst. in Hedwigia 30 (1891) 28,
    et var. *diversifolium* Warnst. Sphag. Univ. (1911) 310,
    et var. *convolutum* Warnst. in Sphag. Univ. (1911) 309.
S. oxycladum Warnst. in Hedwigia 30 (1891) 15.
S. Rehmannii Warnst. in Hedwigia 30 (1891) 16.
S. transvaliense Warnst. in Hedwigia 30 (1891) 32.
S. eschowense Warnst. Sphag. Univ. (1911) 328.

Fig. 6 and Pl. IX, Nos. 1 to 9.

S. truncatum sens. lat. Hyaline cortex of one or two layers of cells, woody cylinder pale-yellow or fuscous. Stem-leaves broadly lingulate to elongated-lingulate, apex rarely obtuse and entire, more usually truncate and 3—12-dentate, narrowly to broadly bordered by 4—8 rows of narrow, elongated, pitted cells, hyaline cells elongate-vermiform, densely fibrous in the upper portion or throughout the leaf. Hyaline cells of stem-leaf simple, or with one oblique septum, or multiseptate (Fig. 6Sl, characteristic of *S. oligodon* C.M.), pores few, usually one at each end of the cell, or a few commissural pores, or none in some aquatic forms.

Branch-leaves usually broadest at the base of a branch, becoming narrower and longer towards its apex, ovate to lanceolate, apex truncate, 3—12-dentate, rarely entire; margin with a border of elongated cells 2—15 cells wide (Fig. 6Bc). Hyaline cells much elongated, vermiform or sinuous, pores various, as in stem-leaves.

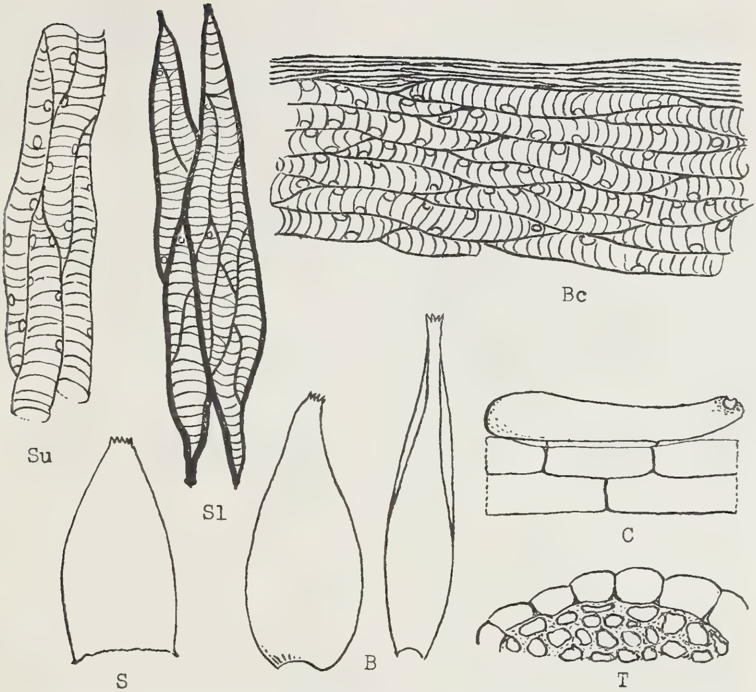

Fig. 6. *S. truncatum* Horns. emend. Garside. Sl. from *Rehmann* Ex. No. 14 (there named *S. oligodon* C.M.) from Inanda, Natal; the remainder from *Pillans* 9990, Cape Peninsula.

This species, which is found in a series of habitats, from aquatic to sub-terrestrial, exhibits a great range of growth-form, so that almost every specimen of it which reached Europe was given a distinct name, resulting in a long list of synonyms, but although both C. Müller and Warnstorf have left us excellent descriptions of the plants they examined, many intermediate forms can be found which are not covered by these. Le Roy Andrews (4, p. 4), speaking of Warnstorf's methods says: "In most cases, neither these long descriptions nor the involved keys furnished by Warnstorf contain actually specific descriptions. Any really critical student can hardly escape the impression that Warnstorf was not, in his later years, seriously trying to recognise species, but like Carl Müller, to make of almost every exotic specimen a species—" It will be convenient for the present therefore, to place all the "species" given in the synonymy at the head of this section under the oldest name, *S. truncatum* Horns. because the differences between the "species" are nothing more fundamental than variations in growth-form, and slight differences in cell-detail, probably correlated with external conditions.

S. truncatum Horns. is a marsh plant, collected by Drège from Du Toit's Kloof, where it has recently again been collected.

Dr. Sim regarded it as a distinct species, though his herbarium contains only one very poor specimen (leg. *Marloth* 147, from a pool at Muizenberg), a plant very similar to that on Pl. IX, No. 6.

As a result, he separated from it all the drier habitat forms with closely imbricated leaves, calling these *S. Rehmannii* Warnst. emend. Sim (6, p. 132), a name which seems to have been selected because of the distinctive growth-form associated with it. Broadly speaking, he attempted to separate the aquatic and sub-aquatic forms illustrated on Pl. IX, Nos. 4, 5 and 6, from the forms of drier habitat, Nos. 7, 8 and 9, but as numerous minor intermediate forms occur, or forms combining aquatic characters in the lower parts with characters associated with drier conditions in the upper parts, it is impossible to make such a distinction.

S. truncatum sens. lat. is probably the commonest and most variable species in South Africa, and has a wide range through the country where conditions are suitable, from the mountains of the Western Province to Natal. Fruiting specimens have never been found, and its mode of distribution presents an ecological problem of interest. Juvenile forms are frequent, and *S. eschowense* Warnst. from Zululand, known only from the type, seems to be one of these.

S. truncatum sens. lat. extends its geographical range to Madagascar; recorded as *S. Rehmannii* and *S. oxycladum* (5, p. 53).

8. S. panduraefolium C.M. in Flora (1887) 418 pp. et Warnst. in Hedwigia 30 (1891) 26.

Fig. 7 and Pl. X, No. 5.

Plants 2 to 8 cm. high, growing in thick tufts, stems simple or divided, but without true fascicle-branches, or rarely with these in fascicles of 2 or 3. Stem-leaves cucullate at the apex which is entire or minutely dentate; hyaline cells fibrous throughout the leaf, and with a few pores on both surfaces, especially near the apex. In the material figured here the pores are very numerous on the convex face (Fig. 7Sm, right-hand figure), and absent from the concave (inner) face of the leaf (Fig. 7Sm, left-hand figure). These are pore variations, a considerable range of which will probably be found. Warnstorf remarks (Hedwigia, 1891, p. 27): "Macht ganz den Eindruck einer noch nicht volkommen entwickelten Pflanze."

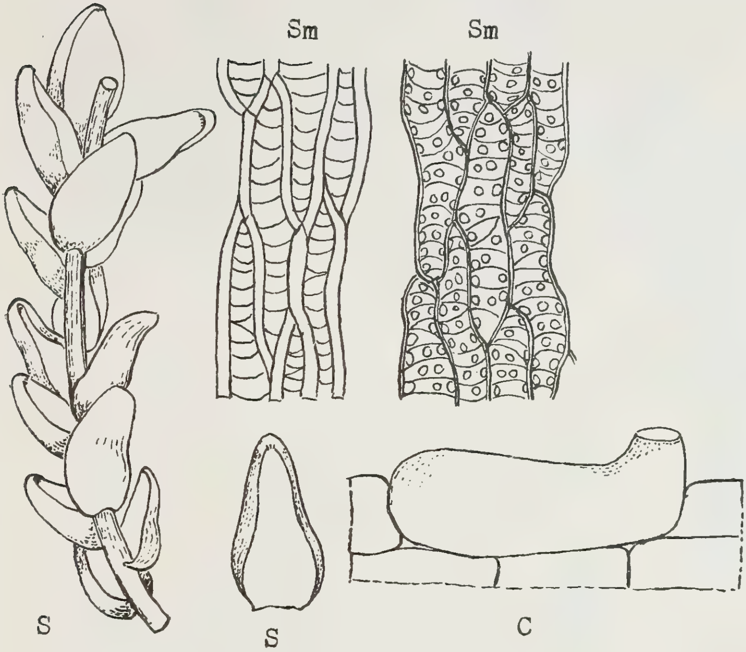

Fig. 7. *S. panduraefolium* C.M. From *Esterhuysen* 15560, Weenen, Natal.

The type was collected by *Rehmann*, Table Mountain, Cape Town, Nov. 1887. Its distribution in South Africa is not well known, as it has been very little collected. The material here figured is from Natal, Weenen Div., *Esterhuysen* 15560.

See also the remarks under *S. capense*.

9. S. capense Horns. emend. Garside, including:—
S. capense Horns. in Linnaea 15 (1841) 113,
et var. *multiporosum* Warnst. Sphag. Univ. (1911) 428.
S. austro-molle C.M. in Flora (1887) 419.
S. mollissimum C.M. in Flora (1887) 418.
S. panduraefolium C.M. in Flora (1887) 418 pp. et Warnst. in Hedwigia 30 (1891) 26.
S. Beyrichianum Warnst. in Hedwigia 36 (1897) 157.
S. pycnocladulum C.M. in Flora (1887) 420,
et var. *viride* Warnst. Sphag. Univ. (1911) 176,
et var. *fuscescens* Warnst. Sphag. Univ. (1911) 176.

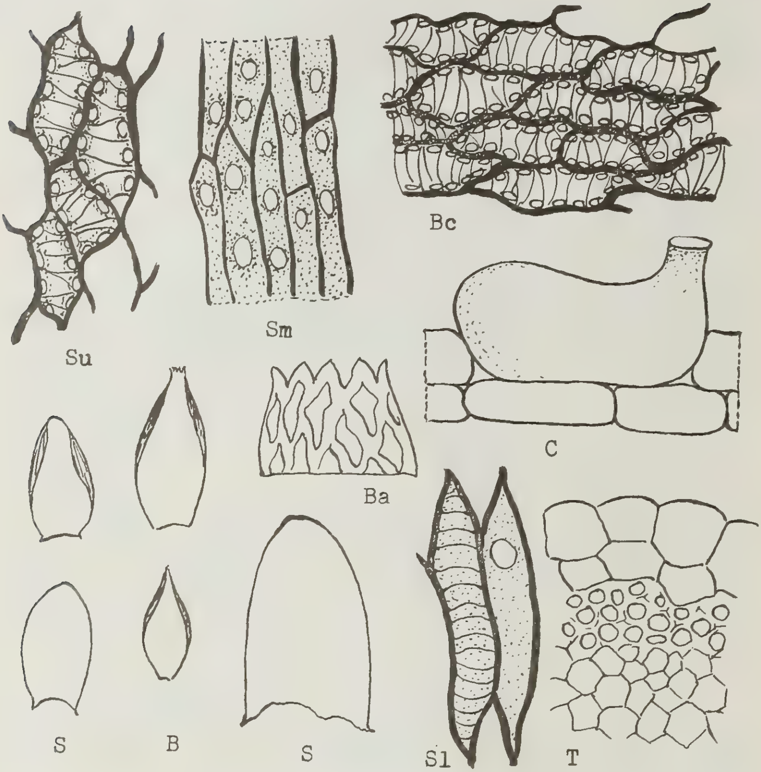

Fig. 8. *S. capense* Horns. S (large leaf), B (large leaf), Ba, Sl, and T, all from *Garside* 6184, Window Gorge, Table Mtn., Cape; the remainder from *Rehmann* Ex. No. 433c, Cape Town.

Plate IX. *Sphagnum truncatum* sens. lat.

Nos. 1—3. Juvenile states. *Esterhuysen* 15430, Table Mountain, below Corridor Buttress, in marsh.

Nos. 4—9. Growth-forms.

No. 4. *Esterhuysen* 15867, Sanddrift Kloof, Hex River, in running water.

No. 5. *Esterhuysen* 15442, Wynberg Reservoir, Table Mtn., Cape.

No. 6. *Esterhuysen* 15970, Marsh at top of Kasteels Poort, Table Mtn., Cape.

No. 7. *A. Wilman* 226. Bain's Kloof, Worcester.

No. 8. Herb. Bolus 24066, leg. Dr. *Levyns*, Mouth of Palmiet River.

No. 9. Herb. Bolus 24073, leg. Mrs. *Middleman*, Mountains between Bot River and Kleinmond.

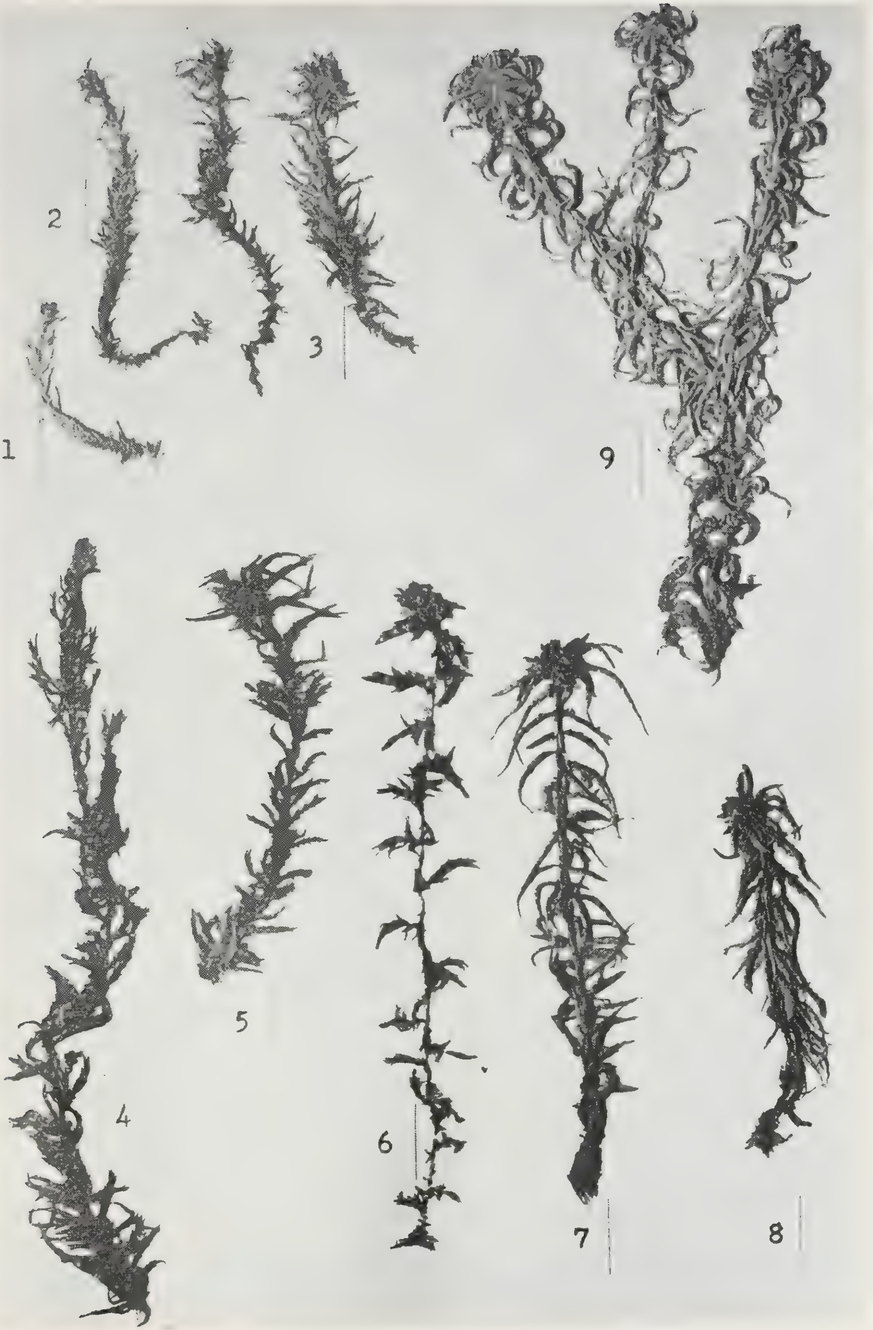

Plate IX.

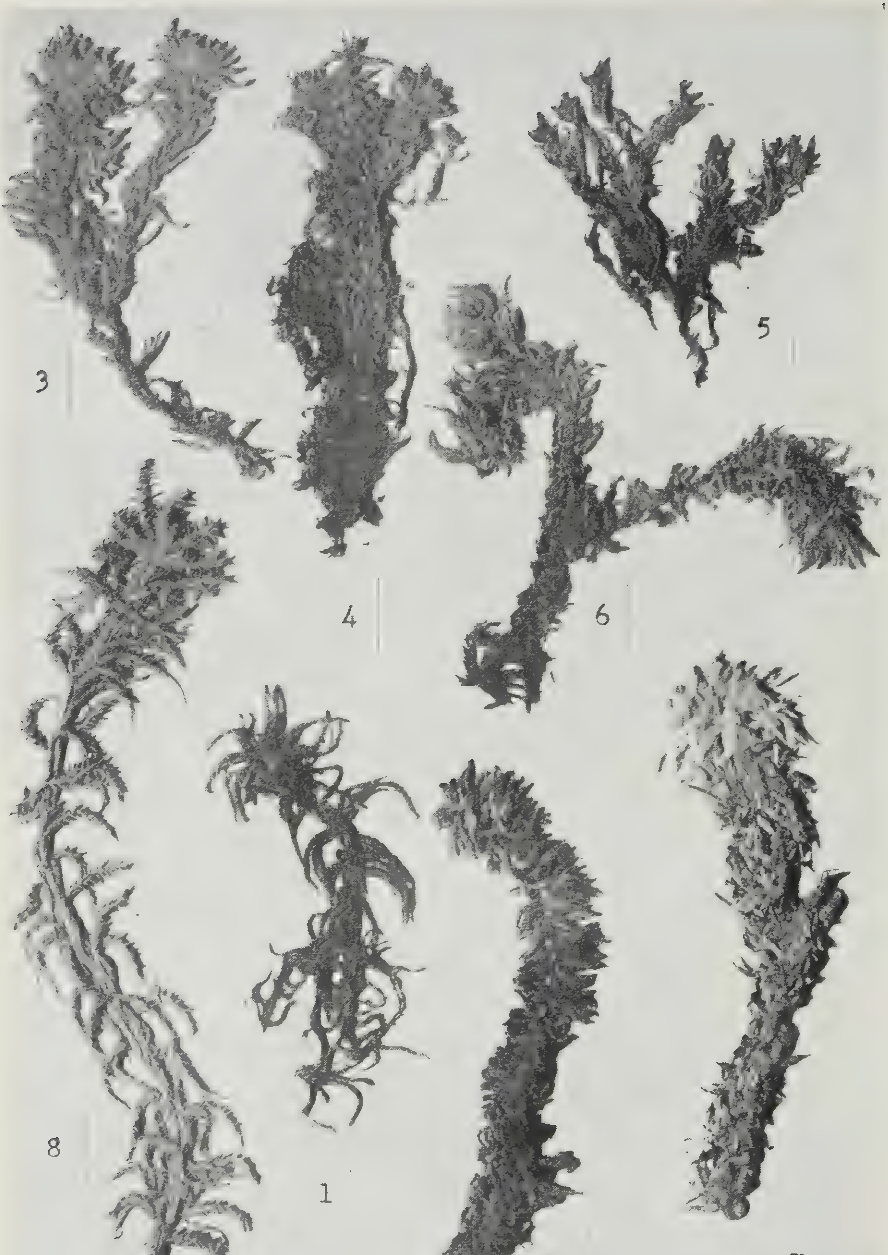

PLATE X.

Fig. 8 and Pl. X, No. 4.

S. panduraefolium C.M. is in all probability a juvenile state, as was suggested by both Warnstorf and Sim, and its leaf-structure indicates that it is probably a juvenile state of *C. capense.*

Moreover, plants can be found in which the lower leaves are cucullate, but the upper leaves show transitions to leaves identical with those of *S. capense.* *S. pycnocladulum*, which has now been found fruiting on two occasions, is obviously a mature state, as it has the stem-leaves well-differentiated from those of the branches.

The stem-leaves of *S. pycnocladulum* have no fibres in any of the hyaline cells, those of *S. capense* have fibres throughout, or in the upper part of the leaf only. This feature, apart from growth-form, is the main difference between the two species. A minor difference is the apex of the branch-leaf, which is typically bifid in *S. pycnocladulum*, has 3 to 5 teeth in *S. capense.* Unfortunately these differences are not completely constant, plants can be found showing all stages of disappearance of the fibres from the stem-leaves; and branch-leaves with two teeth associated with stem-leaves having fibres are found. The treatment suggested for the present is to consider *S. panduraefolium*, *S. capense* and *S. pycnocladulum* as successive stages or growth-forms, under the name *S. capense* sens. lat., as in many cases it is impossible to separate the species with certainty, though it would be well to label herbarium material with a more precise name (as given in the key) if the characters are definitely present. The plexus of species requires considerably more study, and more careful observations in the field should be made.

S. capense Horns. has not been found fruiting so far, it has always been *S. pycnocladulum* which has fruits, a fact which might indicate that *S. capense* Horns. is not a fully developed state.

S. capense Horns. is widely distributed throughout South Africa, and is usually found in the same districts as *S. pycnocladulum*, but that they are in fact the same species has still to be proved.

Plate X.

No. 1. *S. pycnocladulum* C.M. *Esterhuysen* 15427, Waterfall above Sanddrift Kloof, Hex River Mtns.

No. 2. *S. pycnocladulum* C.M. *A. Wilman* 535, River Sonderende Mtns.

No. 3. *S. pycnocladulum* C.M. *Esterhuysen* 15362, Top of Window Gorge, Table Mtn., near stream.

No. 4. *S. capense* Horns. *Esterhuysen* 15431, Blinkwater Ravine, Table Mtn., near stream.

No. 5. *S. panduraefolium* C.M. *Esterhuysen* 15560, Weenen, Drakensberg, Natal, on wet sandstone rocks.

No. 6. *S. laceratum* Warnst. *A. Wilman* 527, Olifants Kloof, foot of Middelberg River Sonderende Mtns.

No. 7. *S. Balfourianum* Warnst. *Esterhuysen* 15839, Steenberg, Table Mtn., Cape.

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